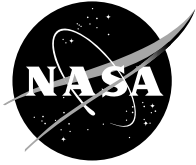


NASA/TM—2000-210042



HBCUs/OMUs Research Conference Agenda and Abstracts

August 2000

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NASA/TM—2000-210042



HBCUs/OMUs Research Conference Agenda and Abstracts

Proceedings of a conference held at and sponsored by
Ohio Aerospace Institute
Cleveland, Ohio
April 25–26, 2000

National Aeronautics and
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August 2000

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GRC HBCUs/OMUs RESEARCH CONFERENCE

APRIL 25–26, 2000

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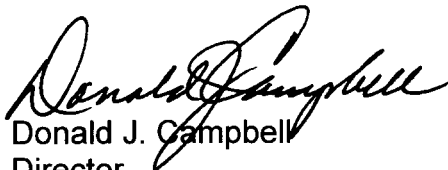
Reply to Attn of:

The NASA John H. Glenn Research Center's (GRC) commitment to excellence continues to grow in terms of investment and support for Historically Black Colleges and Universities (HBCU's)/Other Minority Universities (OMU's). Our total research and development grant awards to HBCU's/OMU's continue to exceed our performance goal by a substantial margin.

GRC's HBCU's/OMU's Research Program is designed to utilize the capabilities of HBCU's/OMU's to conduct fundamental science and develop physical infrastructure related to NASA's disciplines. To reach our goals, we build partnerships with other Government agencies, industry, and academia. Our research partnerships with the Nation's HBCU's/OMU's are an integral part of our strategy.

The HBCU's/OMU's Research Conference is a critical element in ensuring the success of GRC's research programs. In addition, it provides a forum for showcasing the research capabilities of the participating HBCU's/OMU's.

It is with great pleasure that I welcome the participants and congratulate everyone associated with the NASA HBCU's/OMU's Research Conference.


Donald J. Campbell
Director

National Aeronautics and
Space Administration

John H. Glenn Research Center
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Cleveland, OH 44135-3191



Reply to Attn of:

I extend my welcome to all attendees at this Historically Black Colleges and Universities (HBCU's)/Other Minority Universities (OMU's) Research Conference. This Conference provides the opportunity to showcase the high quality of the John H. Glenn Research Center (GRC)-sponsored research conducted at the Nation's HBCU's/ OMU's. I congratulate the Principal Investigators, Student Researchers, and GRC Technical Monitors for your competence and contributions.

I invite all attendees to actively participate with your questions, comments, and suggestions concerning all aspects of the Conference. Your feedback and support are critical to the success of these Conferences.

A handwritten signature in black ink, appearing to read "Julian M. Earls", written in a cursive style.

Julian M. Earls
Deputy Director for Operations

HBCU's/OMU's RESEARCH CONFERENCE

April 25–26, 2000

AGENDA

Presiding: Dr. Sunil Dutta
SDB Program Manager

Tuesday, April 25, 2000

8:00–8:30 a.m.	Registration
8:30–9:00 a.m.	Introduction and Welcome
	Dr. Julian M. Earls Deputy Director for Operations NASA Glenn Research Center
	Dr. Michael J. Salkind President Ohio Aerospace Institute
	Mr. Donald J. Campbell Director NASA Glenn Research Center
9:00–10:20 a.m.	Oral Presentations
10:20–10:40 a.m.	Break
10:40–12:00 Noon	Oral Presentations
12:00–1:30 p.m.	Lunch (On Your Own)
1:30–2:40 p.m.	Oral Presentations
2:40–3:00 p.m.	Break
3:00–4:10 p.m.	Oral Presentations

Wednesday, April 26, 2000

8:30 a.m.–12:00 Noon	NASA HEADQUARTERS CODE R SMALL DISADVANTAGED BUSINESSES (SDB's) FORUM (Continuation of HBCU's/OMU's Research Conference)
8:30–9:00 a.m.	Introduction and Welcome
	Dr. Julian M. Earls Deputy Director for Operations NASA Glenn Research Center
	Dr. Michael J. Salkind President Ohio Aerospace Institute

Mr. Donald J. Campbell
Director
NASA Glenn Research Center

Code R Representative
NASA Headquarters

9:00–12:00 Noon	Awards Ceremony Presentations by SDB's and HBCU's/OMU's
12:00–1:30 p.m.	Lunch (On Your Own)
1:30–3:30 p.m.	Poster Sessions
3:30–4:30 p.m.	Individual Principal Investigator/Technical Monitor Meeting
4:30–5:00 p.m.	Remove Posters

HBCU's/OMU's Research Conference
List of Poster Papers
April 25–26, 2000

P1	Alabama A&M University	"All-Optical Micro Motors Based on Moving Gratings in Photosensitive Media"
P2	Alabama A&M University	"Optical Sensors Based on Single Arm Thin Film Waveguide Interferometer"
P3	City College of New York	"Measurement of the Surface Dilatational Viscosity of an Insoluble Surfactant Monolayer at the Air/Water Interface Using a Pendant Drop Apparatus"
P4	City College of New York	"Surfactant Facilitated Spreading of Aqueous Drops on Hydrophobic Surfaces"
P5	City College of New York	"Remobilizing the Interface of Thermocapillary Driven Bubbles Retarded by the Adsorption of a Surfactant Impurity on the Bubble Surface"
P6	City College of New York	"High Resolution Experiments of Compressible Turbulence Interacting With Shock Waves"
P7	City College of New York	"Ultrasonic Assessment of Impact-Induced Damage and Microcracking in Polymer Matrix Composites"
P8	City College of New York	"Impact Delamination and Fracture in Aluminum/Acrylic Sandwich Plates"
P9	Clark Atlanta University	"Mechanical Characterization of Composites and Foams for Aerospace Applications"
P10	Clark Atlanta University	"Shape Measurement of Large Aerospace Structures Using High Sensitivity Electrical TDR Distributed Strain Sensor"
P11	Clark Atlanta University	"The Test and Evaluation of a Non-Chromate Finishing Agent"
P12	Clark Atlanta University	"Development of Highly Fluorescent Materials Based on Thiophenylimidazole Dyes"
P13	Hampton University	"Advanced Methods for Aircraft Engine Thrust and Noise Benefits: Nozzle-Inlet Flow Analysis"
P14	Howard University	"Experimental Verification of Electric Drive Technologies Based on Artificial Intelligence Tools"
P15	Howard University	"Reliability Constrained Priority Load Shedding for Aerospace Power System Automation"
P16	North Carolina A&T State University	"Structural Modeling Using "Scanning and Mapping" Technique"

P17	Prairie View A&M University	"Radiation Effects on DC-DC Converters"
P18	Savannah State University	"Renewable Energy SCADA/Training Using NASA's Advanced Technology Communications Satellite"
P19	Savannah State University	"Acceptance Testing of a Satellite SCADA Photovoltaic-Diesel Hybrid System"
P20	Southern University	"Knowledge Preservation Techniques That can Facilitate Intergroup Communications"
P21	Tennessee State University	"Tennessee State University (TSU) Research Project for Increasing the Pool of Minority Engineers"
P22	Tennessee State University	"Convective Melting of Particles in Flow Under Microgravity Conditions"
P23	Tuskegee University	"Sputtering Erosion in the Ion Thruster"
P24	Tuskegee University	"p-n Junction Diodes Fabricated on Si-Si/Ge Heteroepitaxial Films"
P25	Wilberforce University	"Student Outreach with Renewable Energy Technology"

GRC HBCU's/OMU's RESEARCH CONFERENCE**All-Optical Micro Motors Based on Moving Gratings in Photosensitive Media**

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ABSTRACT

An all-optical micro motor with a rotor driven by a traveling wave of surface deformation of a stator being in contact with the rotor is being studied. Instead of an ultrasonic wave produced by an electrically driven piezoelectric actuator as in ultrasonic motors, the wave is a result of a photo induced surface deformation of a photosensitive material produced by a traveling holographic grating. Two phase modulated coherent optical beams generate the grating. Several types of photosensitive materials are studied such as photorefractive crystals, photosensitive piezoelectric ceramics, and side-chain liquid crystalline polyesters. In order to be considered as a possible candidate for micro motors, the material should exhibit surface deformation produced by moving grating of the order of 10 micron. Deformations produced by static holographic gratings are studied in photorefractive crystals of LiNbO_3 using high vertical resolution surface profilometer Dektak 3 and surface interferometer WYKO. An experimental set-up with moving grating has been developed. The set-up uses a two-beam interferometry configuration with one beam being reflected by a thin mirror mounted on a loud speaker. A ramp voltage signal generator drives the speaker. Changing voltage, polarity, and frequency of the signal can easily generate vibrating gratings or moving gratings in both directions. A vibrating grating has been applied to a photorefractive crystal of BSO controlled by an external electric field of the order of 10^4 V/cm. We have additionally studied effects of moving grating interaction with light absorbing fluids such as solutions of 2,9,16,23-Tetrakis(phenylthio)-29H, 31H-phthalocyanine in chlorobenzene in capillary tubes. The purpose of using a liquid is to show that the moving gratings can force a liquid to shift. The interaction of a single low power focused laser beam at 633 nm with such fluid produced an intensive circular motion, which also might be applied to all-optical micro motors or actuators.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Optical Sensors Based on Single Arm Thin Film Waveguide Interferometer

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ABSTRACT

Single-arm dual-mode optical waveguide interferometer utilizes interference between two modes of different order. Sensing effect results from the change in propagation conditions of the modes caused by the environment. The waveguide is made as an open asymmetric structure containing a dye-doped polymer film onto a quartz substrate. It is more sensitive to the change of environment than its conventional polarimetric analog using orthogonal modes (TE and TM) of the same order. The sensor still preserves the option of operating in polarimetric regime using a variety of mode combinations such as TE_0/TM_0 (conventional) TE_0/TM_1 , TE_1/TM_0 , or TE_1/TM_1 but can also work in nonpolarimetric regime using combinations TE_0/TE_1 or TM_0/TM_1 . Utilization of different mode combinations simultaneously makes the device more versatile. Application of the sensor to gas sensing is based on doping polymer film with an organic indicator dye targeting a particular gaseous reagent. Change of the optical absorption spectrum of the dye caused by the gaseous pollutant results in change of the reactive index of the dye-doped polymer film that can be detected by the sensor. As indicator dyes we utilize Bromocresol Purple doped into polymer poly(methyl) methacrylate that is sensitive to small concentrations of ammonia. The indicator dye demonstrated an irreversible increase in optical absorption near the peak at 350 nm being exposed to 5% ammonia in pure nitrogen at 600 Torr. The dye also showed reversible growth of the absorption peak near 600 nm after exposure to a vapor of standard medical ammonia spirit (65% alcohol). We have built a breadboard prototype of the sensor with He-Ne laser as a light source and with a single mode fiber input and a multimode fiber output. The prototype showed a sensitivity to temperature change of the order of 2°C per 2π phase shift. The sensitivity of the sensor to the presence of dTy ammonia is not less than 300 ppm per 2π phase shift. The proposed sensor can be used as a robust stand-alone instrument for continuous environment pollution monitoring.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Measurement of the Surface Dilatational Viscosity of an Insoluble Surfactant Monolayer at the Air/Water Interface Using a Pendant Drop Apparatus**

Jose Lorenzo, Alex Couzis and Charles Maldarelli
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Department of Chemical Engineering
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When a fluid interface with surfactants is at rest, the interfacial stress is isotropic (as given by the equilibrium interfacial tension), and is described by the equation of state which relates the surface tension to the surfactant surface concentration. When surfactants are subjected to shear and dilatational flows, flow induced interaction of the surfactants can create interfacial stresses apart from the equilibrium surface tension. The simplest relationship between surface strain rate and surface stress is the Boussinesq-Scriven constitutive equation completely characterized by three coefficients: equilibrium interfacial tension, surface shear viscosity, and surface dilatational viscosity. Equilibrium interfacial tension and surface shear viscosity measurements are very well established. On the other hand, surface dilatational viscosity measurements are difficult because a flow which change the surface area also changes the surfactant surface concentration creating changes in the equilibrium interfacial tension that must be also taken into account. Surface dilatational viscosity measurements of existing techniques differ by five orders of magnitude and use spatially damped surface waves and rapidly expanding bubbles. In this presentation we introduce a new technique for measuring the surface dilatational viscosity by contracting an aqueous pendant drop attached to a needle tip and having an insoluble surfactant monolayer at the air-water interface. The isotropic total tension on the surface consists of the equilibrium surface tension and the tension due to the dilation. Compression rates are undertaken slow enough so that bulk hydrodynamic stresses are small compared to the surface tension force. Under these conditions we show that the total tension is uniform along the surface and that the Young-Laplace equation governs the drop shape with the equilibrium surface tension replaced by the constant surface isotropic stress. We illustrate this technique using DPPC as the insoluble surfactant monolayer and measured for it a surface dilatational viscosity in the LE phase that is 20 surface poise.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Surfactant Facilitated Spreading of Aqueous Drops on Hydrophobic Surfaces

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ABSTRACT

Microgravity technologies often require aqueous phases to spread over nonwetting hydrophobic solid/surfaces. At a hydrophobic surface, the air/hydrophobic solid tension is low, and the solid/aqueous tension is high. A large contact angle forms as the aqueous/air tension acts together with the solid/air tension to balance the large solid/aqueous tension. The aqueous phase, instead of spreading, is held in a meniscus by the large angle. Surfactants facilitate the wetting of water on hydrophobic surfaces by adsorbing on the water/air and hydrophobic solid/water interfaces and lowering the surface tensions of these interfaces. The tension reductions decrease the contact angle, which increases the equilibrium wetted area. Hydrocarbon surfactants (i.e. amphiphiles with a hydrophobic chain of methylene groups attached to a large polar group to give aqueous solubility) do not reduce significantly the contact angles of the very hydrophobic surfaces such as parafilm or polyethylene. Trisiloxane surfactants (amphiphiles with a hydrophobe consisting of methyl groups linked to a trisiloxane backbone in the form of a disk $((\text{CH}_3)_3\text{-Si-O-Si-O-Si}(\text{CH}_3)_3)$) and an extended ethoxylate $(-\text{OCH}_2\text{CH}_2)_n-$ polar group in the form of a chain with seven or eight units) can significantly reduce the contact angle of water on a very hydrophobic surface and cause rapid and complete (or nearly complete) spreading (termed superspreading). The overall goal of the research described in this proposal is to establish and verify a theory for how trisiloxanes cause superspreading, and then use this knowledge as a guide to developing more general hydrocarbon based surfactant systems which superspread and can be used in microgravity. We propose that the trisiloxane surfactants superspread when the siloxane adsorbs, the hydrophobic disk parts of the molecule adsorb onto the surface removing the surface water. Since the cross sectional area of the disk is larger than that of the extended ethoxylate chain, the disks can form a space filling mat on the surface which removes a significant amount of the surface water. The water adjacent to the hydrophobic solid surface is of high energy due to incomplete hydrogen bonding; its removal significantly lowers the tension and reduces the contact angle. Hydrocarbon surfactants cannot remove as much surface water because their large polar groups prevent the chains from cohering lengthwise. In our report last year we presented a poster describing the preparation of model very hydrophobic surfaces which are homogeneous and atomically smooth using self assembled monolayers of octadecyl trichlorosilane (OTS). In this poster we will use these surfaces as test substrates in developing hydrocarbon based surfactant systems which superspread. We studied a binary hydrocarbon surfactant systems consisting of a very soluble large polar group polyethylene oxide surfactant $(\text{C}_{12}\text{E}_6 (\text{CH}_3(\text{CH}_2)_{11}(\text{OCH}_2\text{CH}_2)_6\text{OH}))$ and a long chain alcohol dodecanol. By mixing the alcohol with this soluble surfactant we have found that the contact angle of the mixed system on our test hydrophobic surfaces is very low. We hypothesize that the alcohol fills in the gaps between adjacent adsorbed chains of the large polar group surfactant. This filling in" removes the surface water and effects the decrease in contact angle. We confirm this hypothesis by demonstrating that at the air/water interface the mixed layer forms condensed phases while the soluble large polar group surfactant by itself does not. We present drop impact experiments which demonstrate that the dodecanol/ C_{12}E_6 mixture is effective in causing impacting drops to spread on the very hydrophobic model OTS surfaces.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Remobilizing the Interfaces of Thermocapillary Driven Bubbles Retarded by the Adsorption of a Surfactant Impurity on the Bubble Surface

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Dimitri Papageorgiou
New Jersey Institute of Technology

Thermocapillary migration is a method for moving bubbles in space in the absence of buoyancy. A temperature gradient is applied to the continuous phase in which a bubble is situated, and the applied gradient impressed on the bubble surface causes one pole of the drop to be cooler than the opposite pole. As the surface tension is a decreasing function of temperature, the cooler pole pulls at the warmer pole, creating a flow which propels the bubble in the direction of the warmer fluid. A major impediment to the practical use of thermocapillarity to direct the movement of bubbles in space is the fact that surfactant impurities which are unavoidably present in the continuous phase can significantly reduce the migration velocity. A surfactant impurity adsorbed onto the bubble interface is swept to the trailing end of the bubble. When bulk concentrations are low (which is the case with an impurity), diffusion of surfactant to the front end is slow relative to convection, and surfactant collects at the back end of the bubble. Collection at the back lowers the surface tension relative to the front end setting up a reverse tension gradient. For buoyancy driven bubble motions in the absence of a thermocapillarity, the tension gradient opposes the surface flow, and reduces the surface and terminal velocities (the interface becomes more solid-like). When thermocapillary forces are present, the reverse tension gradient set up by the surfactant accumulation reduces the temperature tension gradient, and decreases to near zero the thermocapillary velocity. The objective of our research is to develop a method for enhancing the thermocapillary migration of bubbles which have been retarded by the adsorption onto the bubble surface of a surfactant impurity. Our remobilization theory proposes to use surfactant molecules which kinetically rapidly exchange between the bulk and the surface and are at high bulk concentrations. Because the remobilizing surfactant is present at much higher concentrations than the impurity, it adsorbs to the bubble much faster than the impurity when the bubble is formed, and thereby prevents the impurity from adsorbing onto the surface. In addition the rapid kinetic exchange and high bulk concentration maintain a saturated surface with a uniform surface concentrations. This prevents retarding surface tension gradients and keeps the velocity high. In our first report last year, we detailed experimental results which verified the theory of remobilization in ground based experiments in which the steady velocity of rising bubbles was measured in a continuous phase consisting of a glycerol/water mixture containing a polyethylene glycol surfactant $C_{12}E_6$ ($CH_3(CH_2)_{11}(OCH_2CH_2)_6OH$). In our report this year, we detail our efforts to describe theoretically the remobilization observed. We construct a model in which a bubble rises steadily by buoyancy in a continuous (Newtonian) viscous fluid containing surfactant with a uniform far field bulk concentration. We account for the effects of inertia as well as viscosity in the flow in the continuous phase caused by the bubble motion (order one Reynolds number), and we assume that the bubble shape remains spherical (viscous and inertial forces are smaller than capillary forces, i.e. small Weber and capillary numbers). The surfactant distribution is calculated by solving the mass transfer equations including convection and diffusion in the bulk, and finite kinetic exchange the bulk and the surface. Convective effects dominate diffusive mass transfer in the bulk of the liquid (high Peclet numbers) except in a thin boundary layer near the surface. A finite volume method is used to numerically solve the hydrodynamic and mass transfer equations on a staggered grid which accounts specifically for the thin boundary layer. We present the results of the nondimensional drag as a function of the bulk concentration of surfactant for different rates of kinetic exchange, from which we develop criteria for the concentration necessary to develop a prescribed degree of remobilization. The criteria compare favorably with the experimental results.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**High Resolution Experiments of Compressible Turbulence Interacting With Shock Waves**

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ABSTRACT

Most of the second year of our research program focused on exploring the potentially favorable the effects of expansion waves on homogeneous and isotropic turbulence, which is formed downstream of a grid. Expansion waves are associated with compressible flows and may reduce the drag over airfoils by suppressing turbulence. In the very few previous investigations of interactions of turbulence with expansion waves the effects due to stabilizing streamline curvature substantially masked the effects of turbulence suppression due to flow expansion though the waves. In the present flow configuration planar expansion waves interact with grid generated turbulence in our high-resolution shock tube research facility. This approach will assess directly the effects of the interaction on turbulence. The first objective of our study was to identify the nature of expansion waves present in our shock tube facility. Our time-dependent numerical simulations of the flow in our facility indicated the existence of two regions of traveling expansion waves. The system of expansion waves utilized in this investigation is generated by the exiting shock wave and the induced flow behind it at the end of the driver. Several new measuring techniques are being developed which are capable of providing velocity-gradient-related quantities in compressible flows for the first time.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Ultrasonic Assessment of Impact-Induced Damage and Microcracking in
Polymer Matrix Composites**

Benjamin Liaw, Glenn Zeichner, and Yanxiong Liu
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Materials Processing and Solid Mechanics Laboratory
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ABSTRACT

The main objective of this NASA FAR project is to conduct ultrasonic assessment of impact-induced damage and microcracking in polymer matrix composites at various temperatures. It is believed that the proposed study of impact damage assessment on polymer matrix composites will benefit several NASA's missions and current interests, such as ballistic impact testing of composite fan containment and high strain rate deformation modeling of polymer matrix composites. Currently, impact-induced delamination and fracture in 6061-T6 aluminum/cast acrylic sandwich plates adhered by epoxy were generated in an instrumented drop-weight impact machine. Although only a small dent was produced on the aluminum side when a hemispherical penetrator tup was dropped onto it from a couple of inches, a large ring of delamination at the interface was observed. The delamination damage was often accompanied by severe shattering in the acrylic substratum. Damage patterns in the acrylic layer include radial and ring cracks and, together with delamination at the interface, may cause peeling-off of acrylic material from the sandwich plate. Theory of stress-wave propagation can be used to explain these damage patterns. The impact tests were conducted at various temperatures. The results also show clearly that temperature effect is very important in impact damage. For pure cast acrylic nil-ductile transition (NDT) occurs between 185-195 °F. Excessive impact energy was dissipated into fracture energy when tested at temperature below this range or through plastic deformation when tested at temperature above the NDT temperature. Results from this study will be used as baseline data for studying fiber-metal laminates, such as GLARE and ARALL for advanced aeronautical and astronautical applications.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Impact Delamination and Fracture in Aluminum/Acrylic Sandwich Plates**

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Materials Processing and Solid Mechanics Laboratory
Convent Avenue and 140th Street
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ABSTRACT

Impact-induced delamination and fracture in 6061-T6 aluminum/cast acrylic sandwich plates adhered by epoxy were generated in an instrumented drop-weight impact machine. Although only a small dent was produced on the aluminum side when a hemispherical penetrator tup was dropped onto it from a couple of inches, a large ring of delamination at the interface was observed. The delamination damage was often accompanied by severe shattering in the acrylic substratum. Damage patterns in the acrylic layer include radial and ring cracks and, together with delamination at the interface, may cause peeling-off of acrylic material from the sandwich plate. Theory of stress-wave propagation can be used to explain these damage patterns. The impact tests were conducted at various temperatures. The results also show clearly that temperature effect is very important in impact damage. For pure cast acrylic nil-ductile transition (NDT) occurs between 185-195 °F. Excessive impact energy was dissipated into fracture energy when tested at temperature below this range or through plastic deformation when tested at temperature above the NDT temperature. Results from this study will be used as baseline data for studying fiber-metal laminates, such as GLARE and ARALL for advanced aeronautical and astronautical applications.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Mechanical Characterization of Composites and Foams for Aerospace Applications**

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ABSTRACT

Experimental studies to investigate the mechanical properties of ultra-lightweight polyimide foams for space applications, compression after impact (CAI) properties for low velocity impact of sandwich composites, and aspen fiber/polypropylene composites containing an interface adhesive additive, Maleic Anhydride Grafted Polypropylene (MAPP), were performed at Clark Atlanta University. Tensile, compression, flexural, and shear modulus tests were performed on TEEK foams categorized by their densities and relative cost according to ASTM specifications. Results showed that the mechanical properties of the foams increased as a function of higher price and increasing density. The CAI properties of Nomex/phenolic honeycomb core, fiberglass/epoxy facesheet sandwich composites for two damage arrangements were compared using different levels of impact energy ranging from 0 - 452 Joules. Impact on the thin side showed slightly more retention of CAI strength at low impact levels, whereas higher residual compressive strength was observed from impact on the thick side at higher impact levels. The aspen fiber/polypropylene composites studied are composed of various percentages (by weight) of aspen fiber and polypropylene ranging from 30%-60% and 40%-100%, respectively. Results showed that the MAPP increases tensile and flexural strength, while having no significant influence on tensile and flexural modulus.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Shape Measurement of Large Aerospace Structures Using High Sensitivity Electrical
TDR Distributed Strain Sensor**

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ABSTRACT

Electrical time domain reflectometry (ETDR) sensing technique can be best described as “closed-loop radar,” where the information is derived from the reflections of a voltage pulse sent through a transmission medium. The ETDR sensing technique is a well-developed method and has been widely used to locate and evaluate discontinuities in long coaxial power transmission cables. The ETDR technique provides a true distributed sensing capability which can not only sense the distributed loading condition of the structure but also can pin-point the location of disturbance, such as the locations of stress concentration and structural damages. Proof-of-concept experiments have been conducted using photoelastic specimens with embedded commercial coaxial cables, i.e., RG85/U and RG174, to demonstrate the stress/strain sensing capability of ETDR sensors for structural health monitoring application. Although the test results showed that the ETDR sensor signals capture specimen deformation pattern both in bending and tension and indicate the location and type of crack damages of the photoelastic specimen; yet, the low signal-to-noise ratio of the sensor signal smears the details of the strain measurement that the ETDR signals can convey. A high-sensitivity ETDR coaxial strain sensor prototype newly developed at Clark Atlanta University will be presented. The construction of the prototype sensing cable as well as its electrical properties relevant to distributed strain sensing application will be shown in details. Test results of the sensitivity and tension responses of the ETDR signal of the prototype sensor will be presented and compared with those of commercial coaxial cables. Promising potentials of the ETDR distributed strain sensing method for shape measurement application of large aerospace structures will also be demonstrated using long slender beam with surface-bonded ETDR distributed strain sensor.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

The Test and Evaluation of a Non-Chromate Finishing Agent

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ABSTRACT

This research is focused on the design, development and implementation of an industry, military and commercial standard testing cell for surface coatings, which focuses on advanced non-chromate materials technology and their commercialization. Currently, within both private and commercial sectors, chromates are used in the corrosion prevention processes. However, there is a great demand for chromate-free systems that are able to provide equal protection. At the end of this effort, it is intended that a patented alternative to chromate conversion coatings would be tested and processed for commercialization. Thus far, research studies have been concerned primarily with current corrosion knowledge and testing methods. Corrosion can be classified into five categories: The first type is *uniform corrosion* which is dominated by a uniform thinning due to an even and regular loss of metal. The second type is called *localized corrosion* in which most of the loss occurs in discrete areas. The third type, *metallurgically influenced corrosion* is a form of attack where metallurgy plays a significant role. The fourth type, titled *mechanically assisted degradation* is a form of attack where velocity, abrasion, and hydrodynamics control the corrosion process. The last type of corrosion is defined as *environmentally induced cracking* which occurs when cracks are produced under specific, premeditated stress. Oddly enough, with these varying classifications, there are not as many standardized corrosion testing sites. Two of the most common testing methods for corrosion are salt spray testing and filiform. Although neither has proven to be absolute, in terms of the resulting observations, our research aims to help provide data that may be used to support the standardization for corrosion testing. We would acquire and use a Singleton Cyclic Corrosion Testing Chamber. Singleton test chambers perform a wide range of commonly used catalytic corrosion tests. They are used throughout the industry, some of which are - automotive, aerospace, electronic and many more. In addition to this, Singleton test chambers are fully expandable to accommodate cyclic corrosion testing needs. Singleton chambers are also designed for complete compliance and conformity with ASTM (American Society for Testing and Materials), military and commercial standards.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Development of Highly Fluorescent Materials Based on Thiophenylimidazole Dyes**

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ABSTRACT

Organic fluorescent materials are expected to find many potential applications in optical devices and photo-functionalized materials. Although many investigations have been focused on heterocyclic compounds such as coumarins, bipyridines, rhodamines, and pyrrole derivatives, little is known for fluorescent imidazole materials. We discovered that one particular class of imidazole derivatives is highly fluorescent. A series of monomeric and polymeric based fluorescent dyes were prepared containing a thiophene unit at the second position of the imidazole ring. Dependence of fluorescence efficiency on parameters such as solvent polarity and substituent groups has been investigated. It was found that a formyl group at the 2-position of the thiophene ring dramatically enhance fluorescence properties. Ion recognition probes indicated their potential as sensor materials. These fluorophores have flexibility for introduction of versatile substituent groups that could improve the fluorescence efficiency and sensor properties.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Advanced Methods for Aircraft Engine Thrust and Noise Benefits: Nozzle-Inlet Flow Analysis

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ABSTRACT

In this project, we continue to develop the previous joint research between the Fluid Mechanics and Acoustics Laboratory (FM&AL) at Hampton University (HU) and the Jet Noise Team (JNT) at the NASA Langley Research Center (NASA LaRC). The FM&AL was established at Hampton University in June of 1996 and has conducted research under two NASA grants: NAG-1-1835 (1996-99), and NAG-1-1936 (1997-00). In addition, the FM&AL has jointly conducted research with the Central AeroHydrodynamics Institute (TsAGI, Moscow) in Russia under a Civilian Research and Development Foundation (CRDF) grant #RE2-136 (1996-99). The goals of the FM&AL programs are twofold: (1) to improve the working efficiency of the FM&AL's team in generating new innovative ideas and in conducting research in the field of fluid dynamics and acoustics, basically for improvement of supersonic and subsonic aircraft engines, and (2) to attract promising minority students to this research and training and, in cooperation with other HU departments, to teach them basic knowledge in Aerodynamics, Gas Dynamics, and Theoretical and Experimental Methods in Aeroacoustics and Computational Fluid Dynamics (CFD). The research at the HU FM&AL supports reduction schemes associated with the emission of engine pollutants for commercial aircraft and concepts for reduction of observables for military aircraft. These research endeavors relate to the goals of the NASA Strategic Enterprise in Aeronautics concerning the development of environmentally acceptable aircraft. It is in this precise area, where the US aircraft industry, academia, and Government are in great need of trained professionals and which is a high priority goal of the Minority University Research and Education (MUREP) Program, that the HU FM&AL can make its most important contribution. The main achievements for the reporting period in the development of concepts for noise reduction and improvement in efficiency for jet exhaust nozzles and inlets for aircraft engines are as follows: (1) Publications: The AIAA Paper #99-1924 has been presented at the 5th AIAA/CEAS Aeroacoustics Conference, May 10-12, 1999, Seattle, WA; the AIAA Paper #00-3315 has been accepted for the 36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 17-19 July, 2000, Huntsville, AL; and another paper has been accepted for the International Environmental Congress, 14-16 June, 2000, St.-Petersburg, Russia. (2) Two patents were granted on July 20, 1999, and January 12, 2000. (3) Three reports/presentations at the NASA LaRC and GRC (06/22/99, 09/26/99, and 06/25/00). (4) Grants and Proposals: Four proposals were submitted to the NASA and CRDF; a NASA Faculty Award was granted on January, 2000. A CRDF Young Investigator Program Award was granted for a 3 months visit of the Russian scientist to the HU FM&AL (03/99-05/99). (5) Theory and Numerical Simulations: Analytical theory, numerical simulation, comparison of theoretical with experimental results, and modification of theoretical approaches, models, grids etc. have been conducted for several complicated 2D and 3D nozzle and inlet designs using NASA codes based on full Euler and Navier-Stokes solvers: CFL3D, CRAFT, GODUNOV, and others. New approach for environmental monitoring via infrasound. (6) Experimental Tests: Experimental acoustic tests at the TsAGI, Moscow, with nozzles having Screwdriver or Axisymmetric Plug and Permeable Shells. A small scale working model of the NASA Low Speed Wind Tunnel (LSWT) has been installed in the Experimental Hall of the HU FM&AL (June, 1999). Preliminary preparations for experimental tests were made. (7) Students Research Activity: Involvement of the two graduate students as research assistants in the current research project.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Experimental Verification of Electric Drive Technologies Based on Artificial Intelligence Tools**

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ABSTRACT

In this report, a fully integrated prototype of a flight servo control system is successfully developed and implemented using brushless dc motors. The control system is developed by the fuzzy logic theory, and implemented with a multilayer neural network. First, a neural network-based architecture is introduced for fuzzy logic control. The characteristic rules and their membership functions of fuzzy systems are represented as the processing nodes in the neural network structure. The network structure and the parameter learning are performed simultaneously and online in the fuzzy-neural network system. The structure learning is based on the partition of input space. The parameter learning is based on the supervised gradient decent method, using a delta adaptation law. Using experimental setup, the performance of the proposed control system is evaluated under various operating conditions. Test results are presented and discussed in the report. The proposed learning control system has several advantages, namely, simple structure and learning capability, robustness and high tracking performance and few nodes at hidden layers. In comparison with the PI controller, the proposed fuzzy-neural network system can yield a better dynamic performance with shorter settling time, and without overshoot. Experimental results have shown that the proposed control system is adaptive and robust in responding to a wide range of operating conditions. In summary, the goal of this study is to design and implement advanced servosystems to actuate control surfaces for flight vehicles, namely, aircraft and helicopters, missiles and interceptors, and mini- and micro-air vehicles.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Reliability Constrained Priority Load Shedding for Aerospace Power System Automation**

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ABSTRACT

The need for improving load shedding on board the space station is one of the goals of aerospace power system automation. To accelerate the optimum load-shedding functions, several constraints must be involved. These constraints include congestion margin determined by weighted probability contingency, component/system reliability index, generation rescheduling. The impact of different faults and indices for computing reliability were defined before optimization. The optimum load schedule is done based on priority, value and location of loads. An optimization strategy capable of handling discrete decision making, such as Everett optimization, is proposed. We extended Everett method to handle expected congestion margin and reliability index as constraints. To make it effective for real time load dispatch process, a rule-based scheme is presented in the optimization method. It assists in selecting which feeder load to be shed, the location of the load, the value, priority of the load and cost benefit analysis of the load profile is included in the scheme. The scheme is tested using a benchmark NASA system consisting of generators, loads and network.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Structural Modeling Using “Scanning and Mapping” Technique**

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ABSTRACT

Supported by NASA Glenn Center, we are in the process developing a structural damage diagnostic and monitoring system for rocket engines, which consists of five modules: Structural Modeling, Measurement Data Pre-Processor, Structural System Identification, Damage Detection Criterion, and Computer Visualization. The function of the system is to detect damage as it is incurred by the engine structures. The scientific principle to identify damage is to utilize the changes in the vibrational properties between the pre-damaged and post-damaged structures. The vibrational properties of the pre-damaged structure can be obtained based on an analytic computer model of the structure. Thus, as the first stage of the whole research plan, we currently focus on the first module - Structural Modeling. Three computer software packages are selected, and will be integrated for this purpose. They are PhotoModeler-Pro, AutoCAD- R14, and MSC/NASTRAN. AutoCAD is the most popular PC-CAD system currently available in the market. For our purpose, it plays like an interface to generate structural models of any particular engine parts or assembly, which is then passed to MSC/NASTRAN for extracting structural dynamic properties. Although AutoCAD is a powerful structural modeling tool, the complexity of engine components requires a further improvement in structural modeling techniques. We are working on a so-called “scanning and mapping” technique, which is a relatively new technique. The basic idea is to producing a full and accurate 3D structural model by tracing on multiple overlapping photographs taken from different angles. There is no need to input point positions, angles, distances or axes. Photographs can be taken by any types of cameras with different lenses. With the integration of such a modeling technique, the capability of structural modeling will be enhanced. The prototypes of any complex structural components will be produced by PhotoModeler first based on existing similar components, then passed to AutoCAD for modification and correction of any discrepancies seen in the Photomodeler version of the 3D-model. These three software packages are fully compatible. The DXF file can be used to transfer drawings among those packages. To begin this entire process, we are using a small replica of an actual engine blade as a test object. This paper introduces the accomplishment of our recent work.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Radiation Effects on DC-DC Converters**

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ABSTRACT

DC-DC switching converters are circuits that can be used to convert a DC voltage of one value to another by switching action. They are increasing being used in space systems. Most of the popular DC-DC switching converters utilize power MOSFETs. However power MOSFETs, when subjected to radiation, are susceptible to degradation of device characteristics or catastrophic failure. This work focuses on the effects of total ionizing dose on converter performance. Four fundamental switching converters (buck converter, buck-boost converter, ĉuk converter, and flyback converter) were built using Harris IRF250 power MOSFETs. These converters were designed for converting an input of 60 volts to an output of about 12 volts with a switching frequency of 100 kHz. The four converters were irradiated with a Co⁶⁰ gamma source at dose rate of 217 rad/min. The performances of the four converters were examined during the exposure to the radiation. The experimental results show that the output voltage of the converters increases as total dose increases. However, the increases of the output voltage were different for the four different converters, with the buck converter and ĉuk converter the highest and the flyback converter the lowest. We observed significant increases in output voltage for ĉuk converter at a total dose of 24 krad (si).

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Renewable Energy SCADA/Training Using NASA's Advanced Technology Communications Satellite

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ABSTRACT

The lack of electrical energy in the rural communities of developing countries is well known, as is the economic unfeasibility of providing much needed energy to these regions via electric grids. Renewable energy (RE) can provide an economic advantage over conventional forms in meeting some of these energy needs. The use of a Supervisory Control and Data Acquisition (SCADA) arrangement via satellite could enable experts at remote locations to provide technical assistance to local trainees while they acquire a measure of proficiency with a newly installed RE system through hands-on training programs using the same communications link. Upon full mastery of the technologies, indigenous personnel could also employ similar SCADA arrangements to remotely monitor and control their constellation of RE systems. Two separate ACTS technology verification experiments (TVEs) have demonstrated that the portability of the Ultra Small Aperture Terminal (USAT) and the versatility of NASA's Advanced Communications Technology Satellite (ACTS), as well as the advantages of Ka band satellites, can be invaluable in providing energy training via distance education (DE), and for implementing renewable energy system SCADA. What has not been tested is the capabilities of these technologies for a simultaneous implementation of renewable energy DE and SCADA. Such concurrent implementations will be useful for preparing trainees in developing countries for their eventual SCADA operations. The project described in this correspondence is the first effort, to our knowledge, in this specific TVE. The setup for this experiment consists of a one-Watt USAT located at Florida Solar Energy Center (FSEC) connected to two satellite modems tuned to different frequencies to establish two duplex ACTS Ka-band communication channels. A short training program on operation and maintenance of the system will be delivered while simultaneously monitoring and controlling the hybrid using the same satellite communications link. The trainees will include faculty and students from Savannah State University, and staff from FSEC. An interactive internet link will be used to allow faculty from the University of West Indies to participate in the training session.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Acceptance Testing of a Satellite SCADA Photovoltaic-Diesel Hybrid System

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ABSTRACT

Satellite Supervisory Control and Data Acquisition (SCADA) of a Photovoltaic (PV)/diesel hybrid system was tested using NASA's Advanced Communication Technology Satellite (ACTS) and Ultra Small Aperture Terminal (USAT) ground stations. The setup consisted of a custom-designed PV/diesel hybrid system, located at the Florida Solar Energy Center (FSEC), which was controlled and monitored at a "remote" hub via Ka-band satellite link connecting two 1/4 Watt USATs in a SCADA arrangement. The robustness of the communications link was tested for remote monitoring of the health and performance of a PV/diesel hybrid system, and for investigating load control and battery charging strategies to maximize battery capacity and lifetime, and minimize loss of critical load probability. Baseline hardware performance test results demonstrated that continuous two-second data transfers can be accomplished under clear sky conditions with an error rate of less than 1%. The delay introduced by the satellite (1/4 sec) was transparent to synchronization of satellite modem as well as to the PV/diesel-hybrid computer. End-to-end communications link recovery times were less than 36 seconds for loss of power and less than one second for loss of link. The system recovered by resuming operation without any manual intervention, which is important since the 4 dB margin is not sufficient to prevent loss of the satellite link during moderate to heavy rain. Hybrid operations during loss of communications link continued seamlessly but real-time monitoring was interrupted. For this sub-tropical region, the estimated amount of time that the signal fade will exceed the 4 dB margin is about 10%. These results suggest that data rates of 4800 bps and a link margin of 4 dB with a 1/4 Watt transmitter are sufficient for end-to-end operation in this SCADA application.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Knowledge Preservation Techniques That can Facilitate Intergroup Communications**

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ABSTRACT

We have developed tools, social methods and software, for (1) acquiring technical knowledge from engineers and scientists, (2) preserving that knowledge, (3) making the totality of our stored knowledge rapidly searchable. Our motivation has been, mainly, to preserve rare knowledge of senior engineers who are near retirement. Historical value of such knowledge, and also of our tools, has been pointed out to us by historians. We now propose the application these tools to enhancing communication among groups that are working jointly on a project. Of most value will be projects having groups among whom communication is rare and incomplete. We propose that discussions among members of a group be recorded in audio and that both the actual audio and transcriptions of that audio, and optional other pieces be combined into electronic, webpage-like “books”. These books can then be searched rapidly by interested people in other groups. At points of particular interest, a searcher can zoom in on the text and even on the original recordings to pick up nuances (e.g. to distinguish a utterance said in seriousness from one in sarcasm). In this matter, not only can potentially valuable technical details be preserved for the future, but communication be enhanced during the life of a joint undertaking.

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GRC HBCUs/OMUs RESEARCH CONFERENCE

Tennessee State University (TSU) Research Project for Increasing the Pool of Minority Engineers

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ABSTRACT

The NASA Glenn Research Center funded the 1998-1999 Tennessee State University (TSU) Research Project for Increasing the Pool of Minority Engineers. The NASA/GRC-TSU Research Project developed a cadre of engineers who have academic and research expertise in technical areas of interest to NASA, in addition to having some familiarity with the mission of the NASA/Glenn Research Center. Increased minority participation in engineering was accomplished by: (1) introducing and exposing minority youth to engineering careers and to the required high school preparation necessary to access engineering through two campus based precollege programs: Minority Introduction to Engineering (MITE), and Engineering and Technology Previews; (2) providing financial support through the Research Scholars Program for minority youth majoring in engineering disciplines of interest to NASA; (3) familiarization with the engineering profession and with NASA through field trips and summer internships at the Space and Rocket Center, and (4) with practical research exposure and experiences through research internships at NASA/GRC and at TSU.

1998-1999 Noteworthy Results

A total of 75 African-American youth participated in three MITE '99 workshops; 32% were females and 68% were males. They came from 14 states: 13% from Alabama, with 35% from Tennessee. Each two-week MITE '99 workshop introduced the participants to aeronautics, enhanced their study of algebra and trigonometry, computer science, and African-American Literature and provided laboratory experience in two engineering laboratories. Field trips were taken to technology centers and to the Space and Rocket Center. The NASA/GRC Sponsored Research Project also provided support for four (4) Engineering and Technology Saturday Previews with a total of 93 middle and high school students in attendance. These students were introduced to the engineering profession through Laboratory experiences in each department in the College. These previews were co sponsored by the College's Business and Industry Cluster, the Johnson City, Tennessee Chapter of Delta Sigma Theta Sorority Inc., the First Baptist Church from Memphis, TN, MLK High School Nashville, TN, and NSBE Birmingham, Alabama Graduate Chapter. In addition to the precollege programs, the Research Project provided scholarships for four (4) mechanical engineering scholars. The average grade-point average for the NASA/GRC Scholars was 3.201. The NASA/GRC sponsored 1998-1999 TSU Research Project of Increasing the Pool of Minority Engineers was an overwhelming success as all goals and objectives were met or exceeded. This research project provided 172 African-American students with academic and research experiences in technical areas of interest to NASA.

Significant Historical Results

Since the inception of the NASA/GRC-TSU Research Project in 1990, 783 high school students (46% female students) have participated in the MITE precollege program. As of 1998, 69% of MITE seniors attend college with 49 % of the MITE seniors enrolled in SMET degree programs, while 33% enrolled at TSU. Since 1990, 15 TSU engineering students participated in the NASA/GRC Research Scholars Program, 12 scholars have had internships at Glenn, 10 have graduated, 4 are presently in the scholars program and one scholar is now pursuing a Ph.D. in Mechanical Engineering at Rensselaer Polytechnic Institute. MITE results are significant given the alarming decline in African-American engineering graduates. The NASA/GRC-TSU Research Project for Increasing the Pool of Minority Engineers produces desired results!

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Convective Melting of Particles in Flow Under Microgravity Conditions**

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ABSTRACT

Study of melting of dispersed or packed solid particles in a fluid under gravity and microgravity conditions provides benchmark information for many engineering applications such as material processing, environmental assessment and protection and space fire protection. During such processes, packed or dispersed solid particles are interacting with fluid flow at above-melting temperatures. By unmasking the buoyancy effects in coupled flow, phase change and heat transport phenomena, a better understanding of melting rate in non-thermal equilibrium, convective conditions can be studied. A series of *flight* experiments were conducted onboard the NASA KC-135 Microgravity Research Airplane. The Particle Melting in Flow (PMF) module was designed to allow flow through the initially packed ice particles at controlled temperature and velocity. To achieve this, a close-loop flow system was designed. Video images were taken to record the visualization of the melting process, from which a time variation of packed particle thickness distribution at different times can be obtained by the image analysis method. The fluid temperature distribution within the melting zone is measured by thermocouples. An infrared camera was mounted from the top of the test section to record the ice- water thermal images at a given location. The results from thermal images yield local temperature variation between melting solid and liquid and local Stephan number. Typical results for a number of cases are presented. The mathematical model, describing mass, energy, and momentum balance equations for the liquid and solid phases, is presented. It is found that melting rate is influenced mainly by the ratio of Reynolds number (based on the initial particle diameter) to the Froude number, and Stephan number. At the absence of gravity, Froude number approaches zero, Reynolds number and Stephan number become dominant factors governing the melting rate. The numerically determined results are compared with the experimental ones. It is found that the discrepancy between the predicted and measured melting rate is largely due to the inaccuracy in the constitutive equations for effective thermal physical properties, such as effective thermal conductivity and diffusivity, and transport properties, such as particle interaction coefficient, and local heat transfer coefficient of particles.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Sputtering Erosion in the Ion Thruster**

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ABSTRACT

During the first phase of this research, the sputtering yields of molybdenum by low-energy (100 eV and higher) xenon ions were measured by using the methods of secondary neutral mass spectrometry (SNMS) and Rutherford backscattering spectrometry (RBS). However, the measured sputtering yields were found to be far too low to explain the sputtering erosions observed in the long-duration tests of ion thrusters. The only difference between the sputtering yield measurement experiments and the ion thruster tests was that the later are conducted at high ion fluences. Hence, a study was initiated to investigate if any linkage exists between high ion fluence and an enhanced sputtering yield. The objective of this research is to gain an understanding of the causes of the discrepancies between the sputtering rates of molybdenum grids in an ion thruster and those measured from our experiments. We are developing a molecular dynamics simulation technique for studying low-energy xenon ion interactions with molybdenum. It is difficult to determine collision sequences analytically for primary ions below the 200 eV energy range where the ion energy is too low to be able to employ a random cascade model with confidence and it is too high to have to consider only single collision at or near the surface. At these low energies, the range of primary ions is about 1 to 2 nm from the surface and it takes less than 4 collisions on the average to get an ion to degrade to such an energy that it can no longer migrate. The fine details of atomic motion during the sputtering process are revealed through computer simulation schemes. By using an appropriate interatomic potential, the positions and velocities of the incident ion together with a sufficient number of target atoms are determined in small time steps. Hence, it allows one to study the evolution of damages in the target and its effect on the sputtering yield. We are at the preliminary stages of setting up the simulation program.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**p-n Junction Diodes Fabricated on Si-Si/Ge Heteroepitaxial Films**

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ABSTRACT

A set of photolithographic masks was designed for the fabrication of diodes in the Si-Si/Ge material system. Fabrication was performed on samples obtained from two different wafers; (1) a complete HBT structure with an n (Si emitter), p (Si/Ge base), and an n/n+ (Si collector/sub-collector) deposited epitaxially (MBE) on a high resistivity p-Si substrate, (2) an HBT structure where epitaxial growth was terminated after the p-type base (Si/Ge) layer deposition. Two different process runs were attempted for the fabrication of Si-Si/Ge (n-p) and Si/Ge-Si (p-n) junction diodes formed between the emitter-base and base-collector layers, respectively, of the Si-Si/Ge-Si HBT structure. One of the processes employed a plasma etching step to expose the p-layer in the structure (1) and to expose the e-layer in structure (2). The Contact metallization used for these diodes was a Cu-based metallization scheme that was developed during the first year of the grant. The plasma-etched base-collector diodes on structure (2) exhibited well-behaved diode-like characteristics. However, the plasma-etched emitter-base diodes demonstrated back-to-back diode characteristics. These back-to back characteristics were probably due to complete etching of the base-layer, yielding a p-n-p diode. The deep implantation process yielded rectifying diodes with asymmetric forward and reverse characteristics. The ideality factor of these diodes were between 1.6 -2.1, indicating that the quality of the MBE grown epitaxial films was not sufficiently high, and also incomplete annealing of the implantation damage. Further study will be conducted on CVD grown films, which are expected to have higher epitaxial quality.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Student Outreach with Renewable Energy Technology**

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ABSTRACT

The Student Outreach with Renewable Energy Technology (SORET) program is an education program involving three Historically Black Colleges and Universities and NASA's John H. Glenn Research Center at Lewis Field. These three universities; Central State University (CSU), Savannah State University (SSU) and Wilberforce University (WU) are working together with NASA Glenn to use the theme of renewable energy to improve the science, engineering and technology education of minority students and to attract minority students to these fields. In this vein, a renewable energy laboratory course is being offered at WU with the goal of giving the students of WU and CSU hands on experiences. As part of this course, the students are constructing solar light posts for a local high school with a high minority population. A Physics teacher from this school and some of his high school students are involved with this project. A lecture course on energy systems and sustainability is being developed by SSU to be delivered via distance reaming to the other institutions. Summer activities are being planned at all three institutions involving student projects in renewable energy. For example, WU students will work on a study of the synthesis and properties of photovoltaic materials. In addition, CSU will present a weeklong summer program to high school students with the assistance of WU. This presentation will focus on the student involvement and achievements in the educational area to date and plot the future course of this program.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Robust Fault Detection for Aircraft Using Mixed Structured Singular Value Theory and Fuzzy Logic**

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ABSTRACT

The purpose of fault detection is to identify when a fault or failure has occurred in a system such as an aircraft or expendable launch vehicle. The faults may occur in sensors, actuators, structural components, etc. One of the primary approaches to model-based fault detection relies on analytical redundancy. That is the output of a computer-based model (actually a state estimator) is compared with the sensor measurements of the actual system to determine when a fault has occurred. Unfortunately, the state estimator is based on an idealized mathematical description of the underlying plant that is never totally accurate. As a result of these modeling errors, false alarms can occur. This research uses mixed structured singular value theory, a relatively recent and powerful robustness analysis tool, to develop robust estimators and demonstrates the use of these estimators in fault detection. To allow qualitative human experience to be effectively incorporated into the detection process fuzzy logic is used to predict the seriousness of the fault that has occurred.

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GRC HBCUs/OMUs RESEARCH CONFERENCE**Aero-Thermo-Structural Analysis of Inlet for Rocket Based Combined Cycle Engines**

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ABSTRACT

NASA has been developing advanced space transportation concepts and technologies to make access to space less costly. One such concept is the reusable vehicles with short turn-around times. The NASA Glenn Research Center's concept vehicle is the Trailblazer powered by a rocket-based combined cycle (RBCC) engine. Inlet is one of the most important components of the RBCC engine. This paper presents fluid flow, thermal, and structural analysis of the inlet for Mach 6 free stream velocity for fully supersonic and supercritical with backpressure conditions. The results concluded that the fully supersonic condition was the most severe case and the largest stresses occur in the ceramic matrix composite layer of the inlet cowl. The maximum tensile and the compressive stresses were at least 3.8 and 3.4, respectively, times less than the associated material strength.

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WHY COSTING IS IMPORTANT ON HBCU GRANTS

WHY IS COST IMPORTANT?

COST

IS OUR ONLY FISCAL MEASURE OF ACTUAL WORK ACCOMPLISHMENT. IT CAN BE UTILIZED BY MANAGEMENT TO EVALUATE THE EFFICIENCY & EFFECTIVENESS OF BUDGET EXECUTION ON OUR PROGRAMS.

WHAT DOES FORWARD FUNDING MEAN?

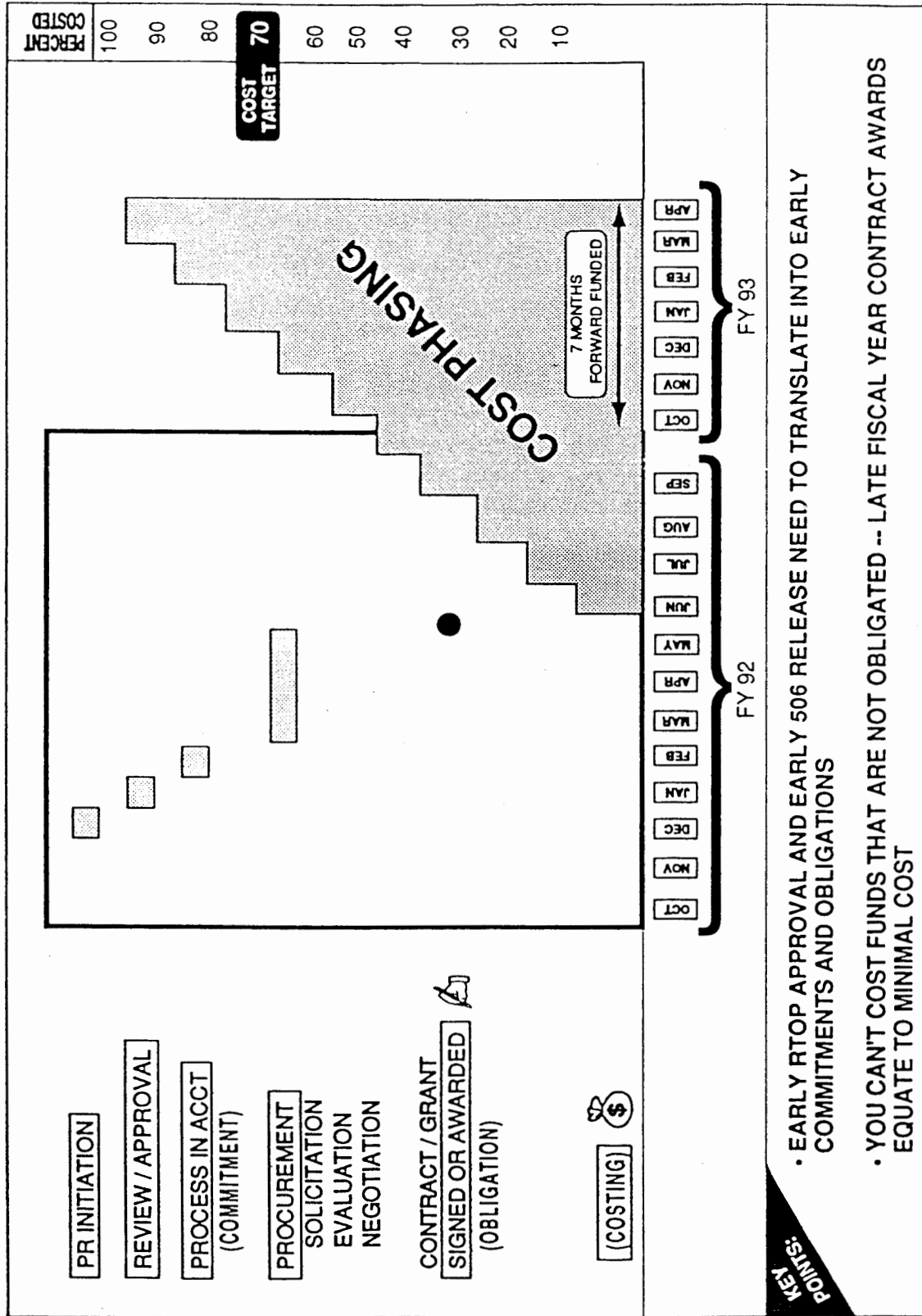
FORWARD FUNDING

IS EXPRESSED AS EITHER

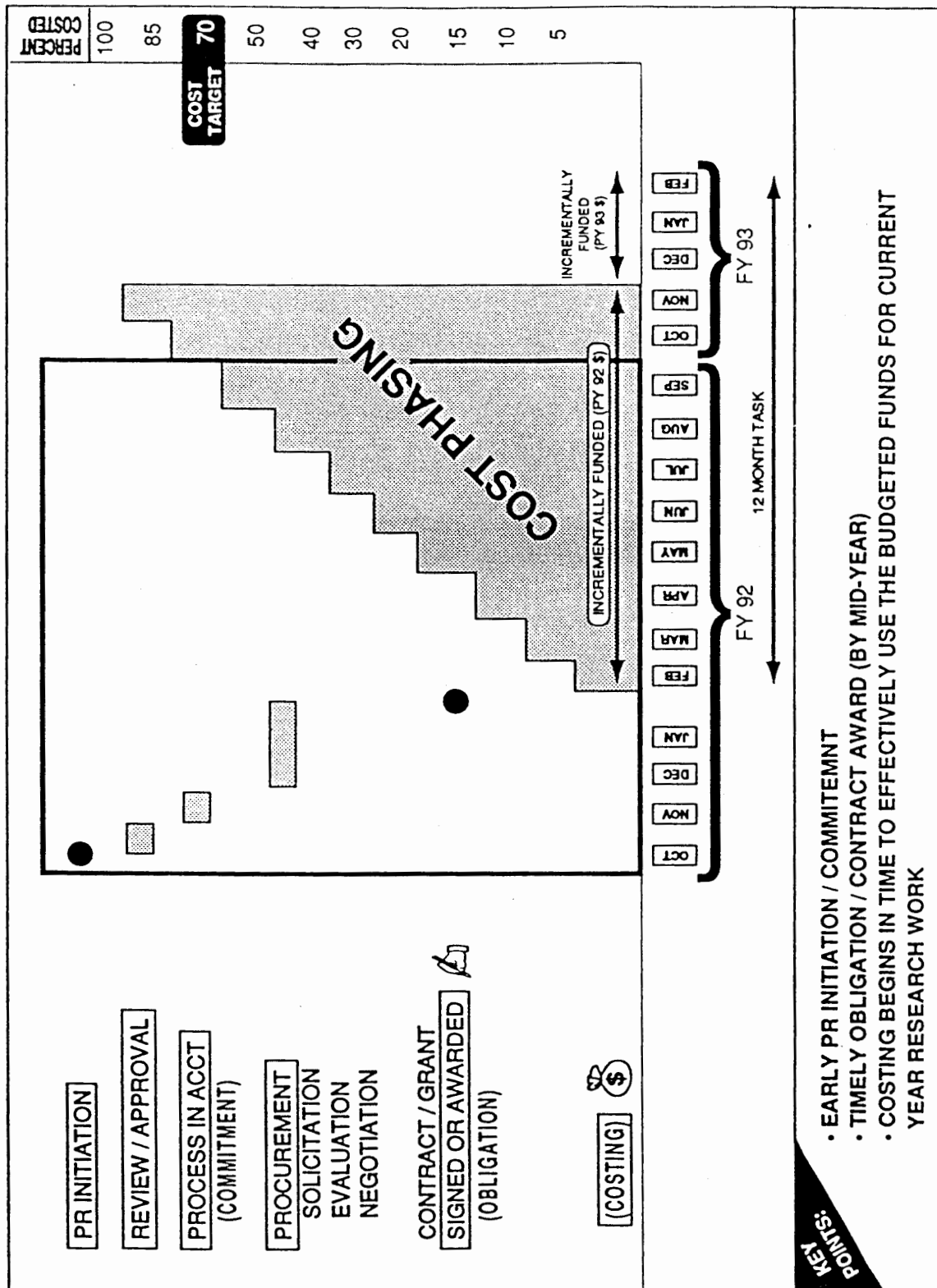
- ① THE AMOUNT OF FUNDING THAT ONE'S PROGRAM OR CONTRACT WILL NOT "COST" DURING THE CURRENT FISCAL YEAR. OR
- ② THE PERIOD OF TIME THAT YOUR CONTRACT IS FORWARD FUNDED INTO THE NEXT FISCAL YEAR.
(NOTE: RB's GUIDELINE IS THAT FORWARD FUNDING BE LIMITED TO NO MORE THAN 2 MONTHS ON ALL OAST CONTRACTS)

WHY COSTING IS IMPORTANT ON HBCU GRANTS

EXAMPLE OF POOR COST MANAGEMENT



EXAMPLE OF GOOD COST MANAGEMENT



COST MANAGEMENT

⚙ CHECKING ACCOUNT ANALOGY ⚙

- CODE R POLICY ALLOWS 2 MONTHS OF FORWARD FUNDING ON CONTRACTS (BEYOND 9/30) AND A CARRYOVER OF 30% OF YOUR BUDGET ALLOCATION TO COVER EXPENDITURES IN THE FOLLOWING FISCAL YEAR
- HOW MANY MONTHS OF FORWARD FUNDING DO YOU MAINTAIN IN YOUR PERSONAL CHECKING ACCOUNT?
- FLIGHT CENTERS AND MAJOR AGENCY PROGRAMS OPERATE WITH LESS THAN 2 WEEKS OF FORWARD FUNDING INTO THE FOLLOWING FISCAL YEAR
- EXTERNAL AUDIT ORGANIZATIONS CAN'T UNDERSTAND WHY WE ASK FOR FUNDS IN OUR BUDGET REQUEST THAT WE WON'T SPEND IN THE CURRENT FISCAL YEAR.



Cost Management

- **NASA MUREP**
 - At least 80% of funds should be costed by the end of Federal fiscal year (September 30)
- **NASA MUREP Grantees**
 - Incremental funding of large \$ value grants or cooperative agreements
 - Minimize forward funding beyond 2 months into the following fiscal year
 - 100% of funds should be encumbered by the end of the grant year; funds not encumbered will be deducted from the first incremental funding, actual carryover will be deducted from the second incremental funding

How Can I Improve My Program's Cost Performance

RB Recommendations

- ① Timelier initiation of procurements
 - "Long leadtime" acquisitions (1st Qtr)
 - Planning PR's / initiations use while awaiting 506 (1st Qtr)
 - Small purchases / off-the-shelf buys (2nd Qtr)
 - Tasks on Support Service Contracts (1st Half of Year)
- ② Expanded use of "Incremental Funding" of Contracts
 - Recommended 2 actions per year (1-1st Qtr; 2-Midyear)
 - Avoid multiyear / 100% funding up-front scenarios
 - Use incremental funding on major fixed-price contracts also
- ③ Limit forward funding on incrementally-funded contracts (or major tasks on Support Service Contracts) to only one month
- ④ Implement a one-time adjustment to start dates on major grants / contracts that are not incrementally funded (startup in 1st Qtr, NOT 4th Qtr)
- ⑤ Ensuring that all legitimate accrued cost on your program is recorded in your Center fiscal systems in a timely and accurate manner
- ⑥ Base Budget Requests upon how much \$ your program will be able to cost over the 12/1/97 - 12/1/98 time frame

**Office of Aeronautics**
National Aeronautics and Space Administration

228-Cost Mgmt. 10/8/96.EH

RECOMMENDATION

- **SUBMIT ALL NECESSARY INFORMATION BILLING TO YOUR COLLEGE FINANCE, ACCOUNTING, OR BILLING OFFICES ON A TIMELY BASIS (AT LEAST ONCE PER MONTH).**
- **INSURE THAT YOUR COLLEGE BILLING OFFICE SUBMITS REQUIRED BILLING INFORMATION TO NASA LEWIS EACH MONTH SO THAT LEWIS MAY PROPERLY REFLECT ACCURATE UP-TO-DATE COSTING ON YOUR HBCU GRANT.**

Donald J. Campbell

Donald J. Campbell is Director of the National Aeronautics and Space Administration's Glenn Research Center in Cleveland, Ohio. He was appointed to this position by NASA Administrator Daniel Goldin on January 6, 1994.

As Director, Mr. Campbell is responsible for planning, organizing, and directing the activities required to accomplish the missions assigned to the Center. Glenn is engaged in research, technology, and systems development programs in aeronautical propulsion, space propulsion, space power, and space sciences/applications. Campbell is responsible for the day-to-day management of these programs, which involve an annual budget of approximately \$1 billion, just under 2800 civil service employees and 2000 support service contractors, and more than 500 specialized research facilities located near Cleveland Hopkins International Airport and at Plum Brook Station in Sandusky, Ohio.

Campbell earned a bachelor's degree in mechanical engineering from Ohio Northern University, a master's degree in mechanical engineering and did predoctoral work at Ohio State University. He completed the Senior Executive Seminar in Management at Carnegie Mellon School of Urban and Public Affairs and the Federal Executive Institute Executive Leadership program. He also completed several senior management courses at Brookings Institute.

Campbell began his government career in 1960 as a test engineer for gas turbine engines and engine components in the Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio. He then worked as a project engineer and later as a program manager for advanced airbreathing propulsion systems.

From February to July 1986, Campbell was assigned as an interim Directorate Chief during the implementation of the National Aerospace Plane (NASP) Program Office, Wright-Patterson Air Force Base. He was Acting Director of the NASP Technology Maturation Directorate. In 1987, he became Acting Deputy Director of the Aero Propulsion Laboratory. In 1988, he was selected for the rank of Senior Executive Service and was appointed Deputy Program Director for the Propulsion System Program Office, Aeronautical Systems Division. He was the senior civilian executive for development and acquisition of new and derivative gas turbine engines for operational aircraft. In 1990, he was appointed Director of the Aero Propulsion and Power Laboratory. He was responsible for the Air Force propulsion and power research and development in the areas of gas turbine engines, ramjet engines, aerospace power systems, and fuels and lubricants.

In 1992, he was named Director of Science and Technology, Office of the Assistant Secretary of the Air Force for Acquisition, Washington, D.C. In this capacity he monitored the Air Force Science and Technology program and other selected research, development, technology, and engineering programs.

Campbell and his wife, Helen, have four children.

Dr. Michael J. Salkind
President, Ohio Aerospace Institute

Michael Salkind was appointed President of the Ohio Aerospace Institute in January 1990. OAI is a consortium of nine Ohio universities, private industry, NASA Glenn Research Center in Cleveland, and Wright-Patterson Air Force Base in Dayton. Its mission is to facilitate collaboration among industry, universities, and federal laboratories to enhance Ohio and U.S. economic competitiveness through research, education, and technology adaptation.

Before his appointment, Dr. Salkind served as Director of Aerospace Sciences, Air Force Office of Scientific Research, in Washington D.C. for 10 years. He was Chief of Structures at NASA Headquarters in Washington, D.C. from 1976 to 1980. From 1964 to 1975, he was with United Technologies Corporation as Chief of Advanced Metallurgy in their corporate research lab and then Chief of Structures and Materials at the Sikorsky Aircraft Division. He received his bachelor's and doctoral degrees in Materials Engineering from Rensselaer Polytechnic Institute in Troy, New York.

A fellow of the American Association for the Advancement of Science and an evaluator for the Accreditation Board for Engineering and Technology, he has published more than 40 articles and a book entitled Applications of Composite Materials.

He has also served on the adjunct faculty of The Johns Hopkins University, University of Maryland, and Trinity College in Hartford, Connecticut.

Dr. Julian M. Earls

Dr. Julian M. Earls, Deputy Director for Operations at the NASA John H. Glenn Research Center at Lewis Field, is a native of Portsmouth, Virginia. He earned the Bachelor's Degree, with distinction, in Physics from Norfolk State University; the Master's Degree in Radiation Physics from the University of Rochester School of Medicine; and the Doctorate Degree in Radiation Physics from the University of Michigan. He also earned the equivalent of a second Master's Degree in Environmental Health from the University of Michigan and is a graduate of the Harvard Business School's prestigious Program for Management Development. In addition, he was awarded the Honorary Doctor of Science degree by the College of Aeronautics in New York.

He has 21 publications, both technical and educational. He has been Distinguished Honors Visiting Professor at numerous universities throughout the Nation. On two separate occasions, he has been awarded NASA medals for exceptional achievement and outstanding leadership. In addition, he has received the Presidential Rank Award of Meritorious Executive. Dr. Earls is a Jennings Foundation Distinguished Scholar Lecturer.

Dr. Earls is co-founder of an organization whose members make personal contributions for scholarships to black students who attend historically black colleges and universities. He has served on many university Boards of Trustees and is a member of the Advisory Board for the Rock and Roll Hall of Fame. He was inducted into the inaugural class of the National Black College Alumni Hall of Fame, with such distinguished individuals as Dr. Martin Luther King, Jr., and Justice Thurgood Marshall.

He holds life memberships in the NMCP and Kappa Alpha Psi Fraternity. He is an avid runner who has run over 10,000 miles in the past 5 years and successfully completed 22 marathons, including the Boston Marathon.

Dr. Earls is married to the former Zenobia Gregory of Norfolk, Virginia, a former Reading Specialist in the Cleveland School System. They have two sons: Julian, Jr., is a neurologist who graduated from Howard University and Case Western Reserve University Medical School; Gregory is a filmmaker who graduated from Norfolk State University and the American Film Institute in Hollywood, California.

Dr. Sunil Dutta

Dr. Sunil Dutta is Program Manager for Small Disadvantaged Businesses (SDBs) at the National Aeronautics and Space Administration's Glenn Research Center, Cleveland, Ohio. Appointed to this position in 1992, he is responsible for implementing policies that ensure the Small Disadvantaged Businesses (SDBs) and Historically Black Colleges and Universities (HBCUs) are encouraged and afforded an equitable opportunity to compete for NASA contracts and research grants. The goal is to increase R&D contracts with SDBs and research grants with HBCUs at Glenn Research Center. Before assuming the present position, his career has been devoted to research and development of materials science and technology, particularly in the area of processing, characterization, and mechanical behavior of high performance ceramics and ceramics matrix composites, for heat engines and high speed civil transport applications. In addition, he monitored numerous R&D contracts and grants for more than 10 years as project/program manager.

Dr. Dutta joined NASA Glenn Research Center in 1976 after 8 years at the U.S. Army Technology Laboratory, Watertown, Massachusetts. Born in India, he received his B.Sc (Hons), and M.S. from Calcutta University, and M.S. and Ph.D. from the University of Sheffield, England. He also received an MBA degree from Babson College, Wellesley, Massachusetts.

Dr. Dutta has written more than 50 publications including 4 patents and 5 chapters in books.

He is a Fellow of the American Ceramic Society, and the Institute of Ceramics in England. He is listed in American Men and Women in Science, Who's Who in Engineering, and Who's Who in the United States.

Dr. Dutta was invited to Japan for one year as Nippon Steel Endowed Chair Visiting Full Professor, at the University of Tokyo's Research Center for Advanced Science & Technology. Since 1987, he visited Germany, Japan, Korea, Singapore, Australia, and India to present invited technical papers/lectures. Also, actively consulted for industry and government including the CSIR (Council of Scientific and Industrial Research) laboratories in India, under the United Nations Development Program (UNDP).

He has actively participated in Local School PTA programs, as Vice-president of Canterbury Homeowners Association, as President of India Association in Boston, Massachusetts, and in Cleveland, Ohio; and co-convenor of 5th biennial National Convention of All Asian-Indians in North America.

Dr. Dutta and his wife Kabita reside in Westlake, Ohio. They have three children.

HBCUs RESEARCH CONFERENCE

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